

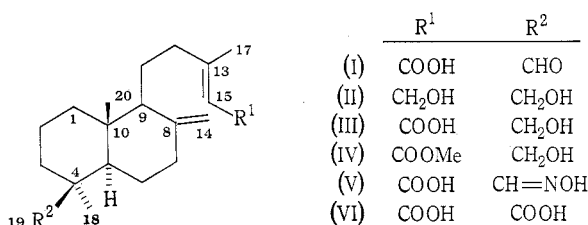
DITERPENOIDS*

XVI.† AGATHALIC ACID—A NEW NATURALLY OCCURRING DITERPENOID

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The oleoresin of black kauri§ (synonyms: blue kauri; blue pine) from north Queensland yields the diterpenoids *cis*- and *trans*-communic acid, abietic acid, neoabietic acid, agathic acid, and monomethylagathic acid.¹

The acid portion of the oleoresin has now given a new aldehydic diterpenoid, agathalic acid (I) (*trans*-19-oxolabda-8(14),13(15)-dien-16-oic acid),|| isolated through the Girard Reagent P.



Agathalic acid was obtained as a gum which yellowed rapidly on heating or exposure to air. It analysed satisfactorily for C₂₀H₃₀O₃ and gave a crystalline oxime and a crystalline semicarbazone. The structure of the compound followed from

TABLE I
P.M.R. VALUES
c/s from TMS at 60 Mc/s; (I) in CCl₄; others in CHCl₃

	C20-CH ₃	C18-CH ₃	C17-CH ₃	C14-CH ₂	C15-CH	Others
(I)	35	60	130	272, 283	336	594 (CHO)
(II)	38	58	131	271, 291	341	199, 209, 222, 232 (CH ₂ O)
(III)	40	60	130	271, 291	340	222 (COOCH ₃); 199, 209, 222, 232 (CH ₂ O)
(IV)	37	65	131	272, 295	342	

the p.m.r. spectrum (Table 1), and from chemical evidence. Reduction of (I) with lithium aluminium hydride gave agathadiol (II), while reduction with sodium borohydride gave agatholic acid (III).

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§ The botanical classification and nomenclature of Australian *Agathis* species will be discussed in a subsequent paper.

|| Nomenclature of the diterpenoids is under review; Rowe, J. W., personal communication.

¹ Carman, R. M., and Marty, R. A., *Aust. J. Chem.*, 1966, **19**, 2403.

Agathalic acid was synthesized from agatholic acid (III) (previously synthesized² from agathic acid (VI)) by chromium trioxide oxidation. The oxime from the synthetic compound was identical in all respects with the oxime from the natural product.

Experimental

P.m.r. spectra were recorded on a Varian A60 spectrometer with TMS as an internal standard. Infrared spectra were determined in Nujol mulls. Optical rotations and ultraviolet spectra were measured in ethanol solutions. Melting points were determined on a Mettler FPI automatic melting point apparatus with a temperature rise of 0.2 deg/min.

Agathalic Acid (I)

The polymeric portion of the oleoresin of black kauri (Davies Creek Road, Atherton, north Queensland) was removed in the usual manner,¹ and the remaining ether-soluble compounds were separated into acids and neutrals.

The acids (60 g) in absolute ethanol (200 ml) and glacial acetic acid (4 ml) were heated under reflux (2 hr) with Girard Reagent P (5 g). The cooled solution was poured into water (250 ml), and the aqueous layer extracted with ether (2 × 1000 ml) and then continuously with ether (36 hr). The aqueous layer was treated with hydrochloric acid (2.5M, 20 ml) and continuously extracted with ether (8 hr). This ether fraction was evaporated at reduced pressure to give an amber gum (1 g) which was about 95% agathalic acid (by p.m.r. spectroscopy).

Chromatography of the crude gum on silica gel gave (from 8% acetone in hexane; decomposition of the product was retarded by collecting the eluent in flasks charged with dry ice) *agathalic acid* (I), $[\alpha]_D +24.5^\circ$ (Found: C, 75.2; H, 9.6. $C_{20}H_{30}O_3$ requires C, 75.4; H, 9.5%). λ_{max} 218 m μ (ϵ 12500). ν_{max} 3080, 2730, 1720, 1695, 1645, 1295, 1255, 890 cm^{-1} . For p.m.r. spectrum see Table 1.

The *oxime* (V) had m.p. 187°, $[\alpha]_D +25^\circ$ (Found: C, 72.1; H, 9.5; N, 4.4. $C_{20}H_{31}NO_3$ requires C, 72.0; H, 9.4; N, 4.2%). λ_{max} 218 m μ (ϵ 13500). ν_{max} 3080, 1680, 1650, 1630, 1300, 975, 890 cm^{-1} . For p.m.r. spectrum, see Table 1.

The *semicarbazone* had m.p. 217° (Found: C, 67.3; H, 9.0; N, 11.2. $C_{21}H_{33}N_3O_3$ requires C, 67.2; H, 8.9; N, 11.2%). λ_{max} 225 m μ (ϵ 22900). ν_{max} 3475, 3220, 3160, 3080, 1690, 1640, 1585, 1290, 1250, 1170, 1125, 940, 890, 760 cm^{-1} .

Agathadiol (II)

Agathalic acid was methylated with diazomethane to give the ester which yellowed rapidly. Direct reduction with lithium aluminium hydride followed by chromatography over alumina (Unilab, neutral, activity I) gave (from hexane-ether, 1:1) *agathadiol* (II), m.p. 106.4°, $[\alpha]_D +28^\circ$ (lit. values for agathadiol;² m.p. 107–108°, $[\alpha]_D +31^\circ$) (Found: C, 78.3; H, 11.3. $C_{20}H_{34}O_2$ requires C, 78.4; H, 11.2%). The p.m.r. and i.r. spectra were superimposable upon those from an authentic sample.

Agatholic Acid (III)

Agathalic acid (500 mg) was reduced with sodium borohydride (500 mg) in aqueous methanol containing sodium hydroxide (30 mg). After 20 hr the mixture was acidified and extracted with ether to give *agatholic acid* (III), m.p. 179.6° (after recrystallization from methanol and ethyl acetate), $[\alpha]_D +40.5^\circ$ (Found: C, 74.9; H, 10.1. $C_{20}H_{32}O_3$ requires C, 75.0; H, 10.1%). λ_{max} 218 m μ (ϵ 14000); i.r. in complete agreement with that reported in the literature;² p.m.r. spectrum, see Table 1. (Literature values for agatholic acid:² m.p. 184–186°, $[\alpha]_D +42^\circ$, λ_{max} 208 m μ (ϵ 13000).)

² Enzell, C., *Acta chem. scand.*, 1961, 15, 1303.

Agatholic acid gave the *methyl ester* (IV), m.p. 77.5° , $[\alpha]_D +40^{\circ}$ (Found: C, 75.3; H, 10.2. $C_{21}H_{34}O_8$ requires C, 75.3; H, 10.3%). λ_{max} 219 $m\mu$ (ϵ 15000). ν_{max} 3520, 3080, 1710, 1655, 1230, 1160, 1050, 870 cm^{-1} . (Literature values for methyl agatholate:² m.p. $77-79^{\circ}$, $[\alpha]_D +44^{\circ}$, λ_{max} 219 (ϵ 13000).)

Synthetic Agathalic Acid

Agatholic acid (III) (500 mg) and CrO_3 (200 mg) were stood in aqueous acetic acid (95%, 50 ml) in a stoppered flask for 16 hr. The reaction mixture was poured into water and the product extracted in ether to give, after normal work-up, a gum (450 mg) which was chromatographed over silica gel to give, from 8% acetone in hexane, *agathalic acid* (I) with i.r. spectrum superimposable upon that from the natural product.

The *oxime*, m.p. 186.4° , mixed m.p. 186.6° , $[\alpha]_D +24^{\circ}$ (Found: C, 71.9; H, 9.4; N, 4.2%) had λ_{max} 218 $m\mu$ (ϵ 15400) and i.r. spectrum superimposable upon that of the oxime from the natural product.

Acknowledgments

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